TuffCut® GP

General Purpose End Mill Recommended Cutting Data - Profile Milling

Length	2 Flute Series		3 Flute Series		4 Flute Series			
Stub	164	166	169		163		165	
Standard	121	150	116	145	111	140	117	114
Long Length	123*				122*			132*

*Chip thinning may not be possible with 122, 123 and 132 series if radial width of cut exceeds 20%.

For ball nose end mills - If axial depth (ap) is less than the ball diameter, the speed is figured using the effective cutting diameter.

Metric

For diameters 6mm and below, see Micro Charts starting on page 369.

Workpiece Material Group	ISO	Hardness	Coolant • Preferred o Possible x Not Possible			Profile Milling (ae)					End Mill Diameter (mm)					
						5%	10%	20%	30%	50%	8	10	12	16	20	25
											ae > .3D use < 1D ap ae < .2D use < 2D ap					
						2.3	1.8	1.2	1.1	1	← Multiply fz by this Factor based on ae. When finishing, use the standard fz per chart below. Only add chip thinning when roughing or semi-finishing.					
			Max.	Air	MMS	vc - m/min Increase speeds by 30% for ALtima® coated tools					fz - mm/tooth					
Free Machining & Low Carbon Steels 1006, 1008, 1015, 1018, 1020, 1022, 1025, 1117, 1140, 1141, 11L08, 11L14, 1213, 12L13, 12L14, 1215, 1330	P	up to 28 Rc	•	•	•	320	215	120	115	110	.0690	.0810	.1140	.1370	.1600	.2290
Medium Carbon & High Carbon Steels, Alloy Steels & Easy to Machine Tool Steels 1030, 1035, 1040, 1045, 1050, 1052, 1055, 1060, 1085, 1095, 1541, 1551, 9255, 2515, 3135, 3415, 4130, 4137, 4140, 4150, 4320, 4340, 4520, 5015, 5115, 5120, 5132, 5140, 5155, 6150, 8620, 9262, 9840, 52100, O1, O2, O6, S2, W1 to W310	P	28 to 38 Rc	•	•	•	200	130	100	75	65	.0690	.0810	.1140	.1370	.1600	.2290
Tool Steels & Die Steels O7, M1, M2, M3, M4, M7, T1, T2, T4, T5, T8, T15, A2, A3, A6, A7, H10, H11, H12, H13, H19, H21, L3, L6, L7, P2, P20, S1, S5, S7, 52100, A 128, D2, D3, D4, D5, D7	P	28 to 44 Rc	•	•	•	160	110	90	85	75	.0690	.0810	.1140	.1370	.1600	.2290
Hardened Steels	H	45-55 Rc	•	o	o	75	73	70	65	60	.0460	.0530	.0760	.0910	.1070	.1520
Hardened Steels	H	55-65 Rc	•	o	o	60	55	50	45	30	.0330	.0360	.0530	.0610	.0740	.1040
Stainless Steel - Easy to Machine 430F, 301, 303, 410, 416 Annealed, 420F, 430, 430F	M	up to 28 Rc	•	x	o	200	185	170	150	140	.0690	.0810	.1140	.1370	.1600	.2290
Stainless Steel - Moderately Difficult 301, 302, 303 High Tensile, 304, 304L, 305, 420, 15-5PH, 17-4PH, 17-7PH	M	up to 28 Rc	•	x	o	160	125	110	90	75	.0690	.0810	.1140	.1370	.1600	.2290
Stainless Steel - Difficult to Machine 302B, 304B, 309, 310, 316, 316B, 316L, 316Ti, 317, 317L, 321, PH13-8Mo, Nitronics	M	over 28 Rc	•	x	o	160	125	110	90	75	.0690	.0810	.1140	.1370	.1600	.2290

Technical data provided should be considered advisory only as variations may be necessary depending on the particular application.

TuffCut® GP

General Purpose End Mill Recommended Cutting Data - Profile Milling

Length	2 Flute Series		3 Flute Series		4 Flute Series			
Stub	164	166	169		163		165	
Standard	121	150	116	145	111	140	117	114
Long Length	123*				122*			132*

*Chip thinning may not be possible with 122, 123 and 132 series if radial width of cut exceeds 20%.

For ball nose end mills - If axial depth (ap) is less than the ball diameter, the speed is figured using the effective cutting diameter.

Metric Continued

For diameters 6mm and below, see Micro Charts starting on page 369.

Workpiece Material Group	ISO	Hardness	Coolant • Preferred o Possible x Not Possible			Profile Milling (ae)					End Mill Diameter (mm)					
						5%	10%	20%	30%	50%	8	10	12	16	20	25
											ae > .3D use < 1D ap ae < .2D use < 2D ap					
						2.3	1.8	1.2	1.1	1	← Multiply fz by this Factor based on ae. When finishing, use the standard fz per chart below. Only add chip thinning when roughing or semi-finishing.					
			Max.	Air	MMS	vc - m/min Increase speeds by 30% for ALtima® coated tools					fz - mm/tooth					
High Temp Alloys Nimonics, Inconel, Monel, Hastelloy	S	up to 42 Rc	•	x	x	80	60	50	45	30	.0360	.0410	.0580	.0690	.0810	.1140
Titanium Alloys 6Al-4V, 5Al-2.5 Sn, 6Al-2 Sn-4Zr-6Mo, 3Al-8V-6Cr4Mo-4Zr, 10V-2Fe-3Al, 13V-11Cr-3Al	S	up to 42 Rc	•	x	x	70	60	55	45	35	.0360	.0410	.0580	.0690	.0810	.1140
Cast-Iron - Gray CG, ASTM A48, CLASS 20, 25, 30, 35, SAE J431C, GRADES G1800, G3000, G3500, GG 10, 15, 20, 25, 30, 35, 40	K	up to 240 HB	•	o	o	130	125	115	110	90	.0690	.0810	.1140	.1370	.1600	.2290
Cast Iron - Ductile & Malleable CGI 60-40-18, 65-45-12, D4018, D4512, D5506, 32510, 35108, M3210, M4504, M5503, 250, 300, 350, 400, 450	K	over 240 HB	•	o	o	100	90	75	65	60	.0690	.0810	.1140	.1370	.1600	.2290
Non-Ferrous, Plastic, Graphite	N		•			300	290	280	260	255	.0690	.0810	.1140	.1370	.1600	.2290

TuffCut® GP

General Purpose End Mill Recommended Cutting Data - Slotting

Length	2 Flute Series		3 Flute Series		4 Flute Series			
Stub	164	166	169		163		165	
Standard	121	150	116	145	111	140	117	114

For ball nose end mills - If axial depth (ap) is less than the ball diameter, the speed is figured using the effective cutting diameter.

Metric

For diameters 6mm and below, see Micro Charts starting on page 369.

Workpiece Material Group	ISO	Hardness	Coolant • Preferred o Possible x Not Possible			Slotting			End Mill Diameter (mm)					
						25%	50%	100%	8	10	12	16	20	25
			Max.	Air	MMS	vc - m/min Increase speeds by 30% for ALtima® coated tools			fz - mm/tooth					
Free Machining & Low Carbon Steels 1006, 1008, 1015, 1018, 1020, 1022, 1025, 1117, 1140, 1141, 11L08, 11L14, 1213, 12L13, 12L14, 1215, 1330	P	up to 28 Rc	•	•	•	120	110	107	.0400	.0500	.0600	.0800	.1000	.1250
Medium Carbon & High Carbon Steels, Alloy Steels & Easy to Machine Tool Steels 1030, 1035, 1040, 1045, 1050, 1052, 1055, 1060, 1085, 1095, 1541, 1551, 9255, 2515, 3135, 3415, 4130, 4137, 4140, 4150, 4320, 4340, 4520, 5015, 5115, 5120, 5132, 5140, 5155, 6150, 8620, 9262, 9840, 52100, O1, O2, O6, S2, W1 to W310	P	28 to 38 Rc	•	•	•	75	70	65	.0400	.0500	.0600	.0800	.1000	.1250
Tool Steels & Die Steels O7, M1, M2, M3, M4, M7, T1, T2, T4, T5, T8, T15, A2, A3, A6, A7, H10, H11, H12, H13, H19, H21, L3, L6, L7, P2, P20, S1, S5, S7, 52100, A 128, D2, D3, D4, D5, D7	P	28 to 44 Rc	•	•	•	65	60	55	.0400	.0500	.0600	.0800	.1000	.1250
Hardened Steels	H	35-45 Rc	•	o	o	55	50	45	.0400	.0500	.0600	.0800	.1000	.1250
Hardened Steels	H	45-55 Rc	•	o	o	55	50	45	.0200	.0250	.0300	.0400	.0500	.0620
Hardened Steels	H	55-65 Rc	•	o	o	50	45	40	.0100	.0120	.0150	.0200	.0250	.0300
Stainless Steel - Easy to Machine 430F, 301, 303, 410, 416 Annealed, 420F, 430, 430F	M	up to 28 Rc	•	x	o	120	115	110	.0400	.0500	.0600	.0800	.1000	.1250
Stainless Steel - Moderately Difficult 301, 302, 303 High Tensile, 304, 304L, 305, 420, 15-5PH, 17-4PH, 17-7PH	M	up to 28 Rc	•	x	o	75	65	55	.0400	.0500	.0600	.0800	.1000	.1250
Stainless Steel - Difficult to Machine 302B, 304B, 309, 310, 316, 316B, 316L, 316Ti, 317, 317L, 321, PH13-8Mo, Nitronics	M	over 28 Rc	•	x	o	65	60	55	.0400	.0500	.0600	.0800	.1000	.1250

General Purpose End Mill Recommended Cutting Data - Slotting

Length	2 Flute Series		3 Flute Series		4 Flute Series			
Stub	164	166	169		163		165	
Standard	121	150	116	145	111	140	117	114

For ball nose end mills - If axial depth (ap) is less than the ball diameter, the speed is figured using the effective cutting diameter.

Metric Continued

For diameters 6mm and below, see Micro Charts starting on page 369.

Workpiece Material Group	ISO	Hardness	Coolant • Preferred o Possible x Not Possible			Slotting			End Mill Diameter (mm)					
						25%	50%	100%	8	10	12	16	20	25
			Max.	Air	MMS	vc - m/min Increase speeds by 30% for ALtima® coated tools			fz - mm/tooth					
High Temp Alloys Nimonics, Inconel, Monel, Hastelloy	S	up to 42 Rc	•	x	x	40	35	30	.0100	.0120	.0150	.0200	.0250	.0300
Titanium Alloys 6Al-4V, 5Al-2.5 Sn, 6Al-2 Sn-4Zr-6Mo, 3Al-8V-6Cr4Mo-4Zr, 10V-2Fe-3Al, 13V-11Cr-3Al	S	up to 42 Rc	•	x	x	30	25	25	.0100	.0120	.0150	.0200	.0250	.0300
Cast-Iron - Gray CG, ASTM A48, CLASS 20, 25, 30, 35, SAE J431C, GRADES G1800, G3000, G3500, GG 10, 15, 20, 25, 30, 35, 40	K	up to 240 HB	•	o	o	135	125	110	.0400	.0500	.0600	.0800	.1000	.1250
Cast Iron - Ductile & Malleable CGI 60-40-18, 65-45-12, D4018, D4512, D5506, 32510, 35108, M3210, M4504, M5503, 250, 300, 350, 400, 450	K	over 240 HB	•	o	o	90	75	70	.0400	.0500	.0600	.0800	.1000	.1250
Non-Ferrous, Plastic, Graphite	N		•			230	180	140	.0400	.0500	.0600	.0800	.1000	.1250

TuffCut® GP

Micro End Mill Recommended Cutting Data - Profile Milling

Length	2 Flute Series		3 Flute Series		4 Flute Series			
Standard	121	150	116	145	111	140	117	114
Long Length	123				122			132

Metric - Standard / Long Length

Ball Nose End Mills - If axial depth (ap) is less than the ball diameter, the speed is figured using the effective cutting diameter.

For diameters > 6mm, see Charts Starting on page 360.

Workpiece Material Group	ISO	Hardness	Coolant • Preferred o Possible x Not Possible			Profile Milling	End Mill Diameter (mm)								
							.4	.8	1.2	1.6	2.0	2.5	3.0	5.0	6.0
							13% Dia. ae			25% Dia. ae					
							<2 Dia. ap			<2 Dia. ap					
			Max.	Air	MMS	vc - m/min Increase speed by 30% for ALtima® coated tools.	fz - mm/tooth								
Free Machining & Low Carbon Steels 1006, 1008, 1015, 1018, 1020, 1022, 1025, 1117, 1140, 1141, 11L08, 11L14, 1213, 12L13, 12L14, 1215, 1330	P	up to 28 Rc	•	•	•	122	0.00170	0.00380	0.00580	0.00680	0.00860	0.01010	0.01370	0.02050	0.02540
Medium Carbon & High Carbon Steels, Alloy Steels & Easy to Machine Tool Steels 1030, 1035, 1040, 1045, 1050, 1052, 1055, 1060, 1085, 1095, 1541, 1551, 9255, 2515, 3135, 3415, 4130, 4137, 4140, 4150, 4320, 4340, 4520, 5015, 5115, 5120, 5132, 5140, 5155, 6150, 8620, 9262, 9840, 52100, O1, O2, O6, S2, W1 to W310	P	28 to 38 Rc	•	•	•	92	0.00170	0.00380	0.00580	0.00680	0.00860	0.01010	0.01370	0.02050	0.02540
Tool Steels & Die Steels O7, M1, M2, M3, M4, M7, T1, T2, T4, T5, T8, T15, A2, A3, A6, A7, H10, H11, H12, H13, H19, H21, L3, L6, L7, P2, P20, S1, S5, S7, 52100, A 128, D2, D3, D4, D5, D7	P	28 to 44 Rc	•	•	•	60	0.00170	0.00380	0.00580	0.00680	0.00860	0.01010	0.01370	0.02050	0.02540
Hardened Steels	H	45-55 Rc	•	o	o	30	0.00250	0.00760	0.01270	0.03500	0.04500	0.05300	0.07600	0.09100	0.10600
Stainless Steel - Easy to Machine 430F, 301, 303, 410, 416 Annealed, 420F, 430, 430F	M	up to 28 Rc	•	x	o	122	0.00170	0.00360	0.00580	0.00680	0.00860	0.01010	0.01370	0.02050	0.02540
Stainless Steel - Moderately Difficult 301, 302, 303 High Tensile, 304, 304L, 305, 420, 15-5PH, 17-4PH, 17-7PH	M	up to 28 Rc	•	x	o	61	0.00170	0.00360	0.00580	0.00680	0.00860	0.01010	0.01370	0.02050	0.02540
Stainless Steel - Difficult to Machine 302B, 304B, 309, 310, 316, 316B, 316L, 316Ti, 317, 317L, 321, PH13-8Mo, Nitronics	M	over 28 Rc	•	x	o	45	0.00170	0.00360	0.00580	0.00680	0.00860	0.01010	0.01370	0.02050	0.02540
Cast Iron	K	160-200 HB	•	o	o	120	0.00170	0.00360	0.00580	0.00680	0.00860	0.01010	0.01370	0.02050	0.02540
Malleable / Ductile Cast Iron	K	200-250 HB	•	o	o	76	0.00170	0.00360	0.00580	0.00680	0.00860	0.01010	0.01370	0.02050	0.02540
High Temp Alloys Nimonics, Inconel, Monel, Hastelloy	S	up to 42 Rc	•	x	x	22	0.00100	0.00200	0.00380	0.00580	0.00680	0.00860	0.01010	0.01370	0.02000
Titanium Alloys 6Al-4V, 5Al-2.5 Sn, 6Al-2 Sn-4Zr-6Mo, 3Al-8V-6Cr4Mo-4Zr, 10V-2Fe-3Al, 13V-11Cr-3Al	S	up to 42 Rc	•	x	x	45	0.00100	0.00200	0.00380	0.00580	0.00680	0.00860	0.01010	0.01370	0.02000
Aluminum < 10 % Si	N		•			228	0.00170	0.00360	0.00580	0.00680	0.00860	0.01010	0.01370	0.02050	0.02540
Aluminum > 10 % Si	N														

Technical data provided should be considered advisory only as variations may be necessary depending on the particular application.

TuffCut® GP

Micro End Mill Recommended Cutting Data - Profile Milling

Length	2 Flute Series		3 Flute Series	4 Flute Series	
Stub	164	166	169	163	165

Metric - Stub Length

Ball Nose End Mills - If axial depth (ap) is less than the ball diameter, the speed is figured using the effective cutting diameter.

For diameters > 6mm, see Charts Starting on page 360.

Workpiece Material Group	ISO	Hardness	Coolant • Preferred o Possible x Not Possible			Profile Milling	End Mill Diameter (mm)								
							.4	.8	1.2	1.6	2.0	2.5	3.0	5.0	6.0
							13% Dia. ae			25% Dia. ae					
							<1 Dia. ap			<1 Dia. ap					
			Max.	Air	MMS	vc - m/min Increase speed by 30% for ALtima® coated tools.	fz - mm/tooth								
Free Machining & Low Carbon Steels 1006, 1008, 1015, 1018, 1020, 1022, 1025, 1117, 1140, 1141, 11L08, 11L14, 1213, 12L13, 12L14, 1215, 1330	P	up to 28 Rc	•	•	•	122	0.00170	0.00380	0.00580	0.00680	0.00860	0.01010	0.01370	0.02050	0.02540
Medium Carbon & High Carbon Steels, Alloy Steels & Easy to Machine Tool Steels 1030, 1035, 1040, 1045, 1050, 1052, 1055, 1060, 1085, 1095, 1541, 1551, 9255, 2515, 3135, 3415, 4130, 4137, 4140, 4150, 4320, 4340, 4520, 5015, 5115, 5120, 5132, 5140, 5155, 6150, 8620, 9262, 9840, 52100, O1, O2, O6, S2, W1 to W310	P	28 to 38 Rc	•	•	•	92	0.00170	0.00380	0.00580	0.00680	0.00860	0.01010	0.01370	0.02050	0.02540
Tool Steels & Die Steels O7, M1, M2, M3, M4, M7, T1, T2, T4, T5, T8, T15, A2, A3, A6, A7, H10, H11, H12, H13, H19, H21, L3, L6, L7, P2, P20, S1, S5, S7, 52100, A 128, D2, D3, D4, D5, D7	P	28 to 44 Rc	•	•	•	60	0.00170	0.00380	0.00580	0.00680	0.00860	0.01010	0.01370	0.02050	0.02540
Hardened Steels	H	45-55 Rc	•	o	o	30	0.00250	0.00760	0.01270	0.03500	0.04500	0.05300	0.07600	0.09100	0.10600
Stainless Steel - Easy to Machine 430F, 301, 303, 410, 416 Annealed, 420F, 430, 430F	M	up to 28 Rc	•	x	o	122	0.00170	0.00360	0.00580	0.00680	0.00860	0.01010	0.01370	0.02050	0.02540
Stainless Steel - Moderately Difficult 301, 302, 303 High Tensile, 304, 304L, 305, 420, 15-5PH, 17-4PH, 17-7PH	M	up to 28 Rc	•	x	o	61	0.00170	0.00360	0.00580	0.00680	0.00860	0.01010	0.01370	0.02050	0.02540
Stainless Steel - Difficult to Machine 302B, 304B, 309, 310, 316, 316B, 316L, 316Ti, 317, 317L, 321, PH13-8Mo, Nitronics	M	over 28 Rc	•	x	o	45	0.00170	0.00360	0.00580	0.00680	0.00860	0.01010	0.01370	0.02050	0.02540
Cast Iron	K	160-200 HB	•	o	o	120	0.00170	0.00360	0.00580	0.00680	0.00860	0.01010	0.01370	0.02050	0.02540
Malleable / Ductile Cast Iron	K	200-250 HB	•	o	o	76	0.00170	0.00360	0.00580	0.00680	0.00860	0.01010	0.01370	0.02050	0.02540
High Temp Alloys Nimonics, Inconel, Monel, Hastelloy	S	up to 42 Rc	•	x	x	22	0.00100	0.00200	0.00380	0.00580	0.00680	0.00860	0.01010	0.01370	0.02000
Titanium Alloys 6Al-4V, 5Al-2.5 Sn, 6Al-2 Sn-4Zr-6Mo, 3Al-8V-6Cr4Mo-4Zr, 10V-2Fe-3Al, 13V-11Cr-3Al	S	up to 42 Rc	•	x	x	45	0.00100	0.00200	0.00380	0.00580	0.00680	0.00860	0.01010	0.01370	0.02000
Aluminum < 10 % Si	N		•			228	0.00170	0.00360	0.00580	0.00680	0.00860	0.01010	0.01370	0.02050	0.02540
Aluminum > 10 % Si	N														

Technical data provided should be considered advisory only as variations may be necessary depending on the particular application.

TuffCut® GP

Micro End Mill Recommended Cutting Data - Slotting

Length	2 Flute Series		3 Flute Series	
Standard	121	150	116	145
Long Length	123			

Metric - Standard / Long Length 2-3 Flute

Ball Nose End Mills - If axial depth (ap) is less than the ball diameter, the speed is figured using the effective cutting diameter.

For diameters > 6mm, see Charts Starting on page 360.

Workpiece Material Group	ISO	Hardness	Coolant • Preferred o Possible x Not Possible			Slotting	End Mill Diameter (mm)								
							.4	.8	1.2	1.6	2.0	2.5	3.0	5.0	6.0
							14%-Dia. ap			35%-Dia. ap					
			Max.	Air	MMS	vc-m/min Increase speed by 30% for ALtima® coated tools.	fz - mm/tooth								
Free Machining & Low Carbon Steels 1006, 1008, 1015, 1018, 1020, 1022, 1025, 1117, 1140, 1141, 11L08, 11L14, 1213, 12L13, 12L14, 1215, 1330	P	up to 28 Rc	•	•	•	122	.0018	.0033	.0051	.0058	.0074	.0089	.0119	.0180	.0241
Medium Carbon & High Carbon Steels, Alloy Steels & Easy to Machine Tool Steels 1030, 1035, 1040, 1045, 1050, 1052, 1055, 1060, 1085, 1095, 1541, 1551, 9255, 2515, 3135, 3415, 4130, 4137, 4140, 4150, 4320, 4340, 4520, 5015, 5115, 5120, 5132, 5140, 5155, 6150, 8620, 9262, 9840, 52100, O1, O2, O6, S2, W1 to W310	P	28 to 38 Rc	•	•	•	100	.0015	.0030	.0048	.0053	.0069	.0081	.0109	.0165	.0218
Tool Steels & Die Steels O7, M1, M2, M3, M4, M7, T1, T2, T4, T5, T8, T15, A2, A3, A6, A7, H10, H11, H12, H13, H19, H21, L3, L6, L7, P2, P20, S1, S5, S7, 52100, A 128, D2, D3, D4, D5, D7	P	28 to 44 Rc	•	•	•	60	.0013	.0028	.0043	.0048	.0061	.0074	.0098	.0147	.0198
Hardened Steels	H	35-45 Rc	•	o	o	30	.0008	.0015	.0023	.0028	.0033	.0041	.0056	.0081	.0109
Stainless Steel - Easy to Machine 430F, 301, 303, 410, 416 Annealed, 420F, 430, 430F	M	up to 28 Rc	•	x	o	122	.0018	.0033	.0051	.0058	.0074	.0089	.0119	.0180	.0241
Stainless Steel - Moderately Difficult 301, 302, 303 High Tensile, 304, 304L, 305, 420, 15-5PH, 17-4PH, 17-7PH	M	up to 28 Rc	•	x	o	60	.0015	.0030	.0048	.0053	.0069	.0081	.0109	.0165	.0218
Stainless Steel - Difficult to Machine 302B, 304B, 309, 310, 316, 316B, 316L, 316Ti, 317, 317L, 321, PH13-8Mo, Nitronics	M	over 28 Rc	•	x	o	45	.0010	.0020	.0030	.0033	.0043	.0051	.0069	.0102	.0137
Cast Iron	K	160-200 HB	•	o	o	120	.0018	.0033	.0051	.0058	.0074	.0089	.0119	.0180	.0241
Malleable / Ductile Cast Iron	K	200-250 HB	•	o	o	76	.0015	.0030	.0048	.0053	.0069	.0081	.0109	.0165	.0218
High Temp Alloys Nimonics, Inconel, Monel, Hastelloy	S	up to 42 Rc	•	x	x	22	.0010	.0020	.0030	.0033	.0043	.0051	.0069	.0102	.0137
Titanium Alloys 6Al-4V, 5Al-2.5 Sn, 6Al-2 Sn-4Zr-6Mo, 3Al-8V-6Cr4Mo-4Zr, 10V-2Fe-3Al, 13V-11Cr-3Al	S	up to 42 Rc	•	x	x	45	.0010	.0020	.0030	.0033	.0043	.0051	.0069	.0102	.0137
Aluminum < 10 % Si	N		•			228	.0038	.0078	.0114	.0139	.0175	.0208	.0279	.0419	.0558
Aluminum > 10 % Si	N														

TuffCut® GP

Micro End Mill Recommended Cutting Data - Slotting

Length	2 Flute Series		3 Flute Series
Stub	164	166	169

Metric - Stub Length 2-3 Flute

Ball Nose End Mills - If axial depth (ap) is less than the ball diameter, the speed is figured using the effective cutting diameter.

For diameters > 6mm, see Charts Starting on page 360.

Workpiece Material Group	ISO	Hardness	Coolant • Preferred o Possible x Not Possible			Slotting	End Mill Diameter (mm)								
							.4	.8	1.2	1.6	2.0	2.5	3.0	5.0	6.0
							14%-Dia. ap			35%-Dia. ap					
			Max.	Air	MMS	vc - m/min Increase speed by 30% for ALtima® coated tools.	fz - mm/tooth								
Free Machining & Low Carbon Steels 1006, 1008, 1015, 1018, 1020, 1022, 1025, 1117, 1140, 1141, 11L08, 11L14, 1213, 12L13, 12L14, 1215, 1330	P	up to 28 Rc	•	•	•	122	.0017	.0038	.0056	.0066	.0081	.0099	.0132	.0198	.0254
Medium Carbon & High Carbon Steels, Alloy Steels & Easy to Machine Tool Steels 1030, 1035, 1040, 1045, 1050, 1052, 1055, 1060, 1085, 1095, 1541, 1551, 9255, 2515, 3135, 3415, 4130, 4137, 4140, 4150, 4320, 4340, 4520, 5015, 5115, 5120, 5132, 5140, 5155, 6150, 8620, 9262, 9840, 52100, O1, O2, O6, S2, W1 to W310	P	28 to 38 Rc	•	•	•	100	.0015	.0036	.0053	.0060	.0076	.0089	.0121	.0180	.0241
Tool Steels & Die Steels O7, M1, M2, M3, M4, M7, T1, T2, T4, T5, T8, T15, A2, A3, A6, A7, H10, H11, H12, H13, H19, H21, L3, L6, L7, P2, P20, S1, S5, S7, 52100, A 128, D2, D3, D4, D5, D7	P	28 to 44 Rc	•	•	•	60	.0013	.0028	.0043	.0048	.0061	.0074	.0098	.0147	.0198
Hardened Steels	H	35-45 Rc	•	o	o	30	.0008	.0015	.0023	.0028	.0033	.0041	.0056	.0081	.0109
Stainless Steel - Easy to Machine 430F, 301, 303, 410, 416 Annealed, 420F, 430, 430F	M	up to 28 Rc	•	x	o	122	.0018	.0033	.0051	.0058	.0074	.0089	.0119	.0180	.0241
Stainless Steel - Moderately Difficult 301, 302, 303 High Tensile, 304, 304L, 305, 420, 15-5PH, 17-4PH, 17-7PH	M	up to 28 Rc	•	x	o	60	.0015	.0030	.0048	.0053	.0069	.0081	.0109	.0165	.0218
Stainless Steel - Difficult to Machine 302B, 304B, 309, 310, 316, 316B, 316L, 316Ti, 317, 317L, 321, PH13-8Mo, Nitronics	M	over 28 Rc	•	x	o	45	.0010	.0020	.0030	.0033	.0043	.0051	.0069	.0102	.0137
Cast Iron	K	160-200 HB	•	o	o	120	.0017	.0038	.0055	.0066	.0081	.0099	.0132	.0198	.0254
Malleable / Ductile Cast Iron	K	200-250 HB	•	o	o	76	.0015	.0035	.0053	.0060	.0076	.0088	.0121	.0180	.0241
High Temp Alloys Nimonics, Inconel, Monel, Hastelloy	S	up to 42 Rc	•	x	x	22	.0010	.0020	.0030	.0033	.0043	.0051	.0069	.0102	.0137
Titanium Alloys 6Al-4V, 5Al-2.5 Sn, 6Al-2 Sn-4Zr-6Mo, 3 Al-8V-6Cr4Mo-4Zr, 10V-2Fe-3Al, 13V-11Cr-3Al	S	up to 42 Rc	•	x	x	45	.0010	.0020	.0030	.0033	.0043	.0051	.0069	.0102	.0137
Aluminum < 10 % Si	N		•			230	.0038	.0078	.0114	.0139	.0175	.0208	.0279	.0419	.0558
Aluminum > 10 % Si	N														

TuffCut® GP

Micro End Mill Recommended Cutting Data - Slotting

Length	4 Flute Series			
Standard	111	140	117	114
Long Length	122			132

Metric - Standard / Long Length 4 Flute

Ball Nose End Mills - If axial depth (ap) is less than the ball diameter, the speed is figured using the effective cutting diameter.

For diameters > 6mm, see Charts Starting on page 360.

Workpiece Material Group	ISO	Hardness	Coolant • Preferred o Possible x Not Possible			Slotting	End Mill Diameter (mm)								
							.4	.8	1.2	1.6	2.0	2.5	3.0	5.0	6.0
							14%-Dia. ap			35%-Dia. ap					
			Max.	Air	MMS	vc - m/min Increase speed by 30% for ALtima® coated tools.	fz - mm/tooth								
Free Machining & Low Carbon Steels 1006, 1008, 1015, 1018, 1020, 1022, 1025, 1117, 1140, 1141, 11L08, 11L14, 1213, 12L13, 12L14, 1215, 1330	P	up to 28 Rc	•	•	•	122	.0018	.0033	.0051	.0058	.0074	.0089	.0119	.0180	.0241
Medium Carbon & High Carbon Steels, Alloy Steels & Easy to Machine Tool Steels 1030, 1035, 1040, 1045, 1050, 1052, 1055, 1060, 1085, 1095, 1541, 1551, 9255, 2515, 3135, 3415, 4130, 4137, 4140, 4150, 4320, 4340, 4520, 5015, 5115, 5120, 5132, 5140, 5155, 6150, 8620, 9262, 9840, 52100, O1, O2, O6, S2, W1 to W310	P	28 to 38 Rc	•	•	•	100	.0015	.0030	.0048	.0053	.0069	.0081	.0109	.0165	.0218
Tool Steels & Die Steels O7, M1, M2, M3, M4, M7, T1, T2, T4, T5, T8, T15, A2, A3, A6, A7, H10, H11, H12, H13, H19, H21, L3, L6, L7, P2, P20, S1, S5, S7, 52100, A 128, D2, D3, D4, D5, D7	P	28 to 44 Rc	•	•	•	60	.0013	.0028	.0043	.0048	.0061	.0074	.0098	.0147	.0198
Hardened Steels	H	35-45 Rc	•	o	o	30	.0008	.0015	.0023	.0028	.0033	.0041	.0056	.0081	.0109
Stainless Steel - Easy to Machine 430F, 301, 303, 410, 416 Annealed, 420F, 430, 430F	M	up to 28 Rc	•	x	o	122	.0018	.0033	.0051	.0058	.0074	.0089	.0119	.0180	.0241
Stainless Steel - Moderately Difficult 301, 302, 303 High Tensile, 304, 304L, 305, 420, 15-5PH, 17-4PH, 17-7PH	M	up to 28 Rc	•	x	o	60	.0015	.0030	.0048	.0053	.0069	.0081	.0109	.0165	.0218
Stainless Steel - Difficult to Machine 302B, 304B, 309, 310, 316, 316B, 316L, 316Ti, 317, 317L, 321, PH13-8Mo, Nitronics	M	over 28 Rc	•	x	o	45	.0010	.0020	.0030	.0033	.0043	.0051	.0069	.0102	.0137
Cast Iron	K	160-200 HB	•	o	o	120	.0018	.0033	.0051	.0058	.0074	.0089	.0119	.0180	.0241
Malleable / Ductile Cast Iron	K	200-250 HB	•	o	o	76	.0015	.0030	.0048	.0053	.0069	.0081	.0109	.0165	.0218
High Temp Alloys Nimonics, Inconel, Monel, Hastelloy	S	up to 42 Rc	•	x	x	22	.0010	.0020	.0030	.0033	.0043	.0051	.0069	.0102	.0137
Titanium Alloys 6Al-4V, 5Al-2.5 Sn, 6Al-2 Sn-4Zr-6Mo, 3Al-8V-6Cr4Mo-4Zr, 10V-2Fe-3Al, 13V-11Cr-3Al	S	up to 42 Rc	•	x	x	45	.0010	.0020	.0030	.0033	.0043	.0051	.0069	.0102	.0137
Aluminum < 10 % Si	N		•			228	.0038	.0078	.0114	.0139	.0175	.0208	.0279	.0419	.0558
Aluminum > 10 % Si	N														

TuffCut® GP

Micro End Mill Recommended Cutting Data - Slotting

Length	4 Flute Series	
Stub	163	165

Metric - Stub Length 4 Flute

Ball Nose End Mills - If axial depth (ap) is less than the ball diameter, the speed is figured using the effective cutting diameter.

For diameters > 6mm, see Charts Starting on page 360.

Workpiece Material Group	ISO	Hardness	Coolant • Preferred o Possible x Not Possible			Slotting	End Mill Diameter (mm)								
							.4	.8	1.2	1.6	2.0	2.5	3.0	5.0	6.0
							14%-Dia. ap			35%-Dia. ap					
			Max.	Air	MMS	vc - m/min Increase speed by 30% for ALtima® coated tools.	fz - mm/tooth								
Free Machining & Low Carbon Steels 1006, 1008, 1015, 1018, 1020, 1022, 1025, 1117, 1140, 1141, 11L08, 11L14, 1213, 12L13, 12L14, 1215, 1330	P	up to 28 Rc	•	•	•	122	.0018	.0033	.0051	.0058	.0074	.0089	.0119	.0180	.0241
Medium Carbon & High Carbon Steels, Alloy Steels & Easy to Machine Tool Steels 1030, 1035, 1040, 1045, 1050, 1052, 1055, 1060, 1085, 1095, 1541, 1551, 9255, 2515, 3135, 3415, 4130, 4137, 4140, 4150, 4320, 4340, 4520, 5015, 5115, 5120, 5132, 5140, 5155, 6150, 8620, 9262, 9840, 52100, O1, O2, O6, S2, W1 to W310	P	28 to 38 Rc	•	•	•	100	.0015	.0030	.0048	.0053	.0069	.0081	.0109	.0165	.0218
Tool Steels & Die Steels O7, M1, M2, M3, M4, M7, T1, T2, T4, T5, T8, T15, A2, A3, A6, A7, H10, H11, H12, H13, H19, H21, L3, L6, L7, P2, P20, S1, S5, S7, 52100, A 128, D2, D3, D4, D5, D7	P	28 to 44 Rc	•	•	•	60	.0013	.0028	.0043	.0048	.0061	.0074	.0098	.0147	.0198
Hardened Steels	H	35-45 Rc	•	o	o	30	.0008	.0015	.0023	.0028	.0033	.0041	.0056	.0081	.0109
Stainless Steel - Easy to Machine 430F, 301, 303, 410, 416 Annealed, 420F, 430, 430F	M	up to 28 Rc	•	x	o	122	.0018	.0033	.0051	.0058	.0074	.0089	.0119	.0180	.0241
Stainless Steel - Moderately Difficult 301, 302, 303 High Tensile, 304, 304L, 305, 420, 15-5PH, 17-4PH, 17-7PH	M	up to 28 Rc	•	x	o	60	.0015	.0030	.0048	.0053	.0069	.0081	.0109	.0165	.0218
Stainless Steel - Difficult to Machine 302B, 304B, 309, 310, 316, 316B, 316L, 316Ti, 317, 317L, 321, PH13-8Mo, Nitronics	M	over 28 Rc	•	x	o	45	.0010	.0020	.0030	.0033	.0043	.0051	.0069	.0102	.0137
Cast Iron	K	160-200 HB	•	o	o	120	.0018	.0033	.0051	.0058	.0074	.0089	.0119	.0180	.0241
Malleable / Ductile Cast Iron	K	200-250 HB	•	o	o	76	.0015	.0030	.0048	.0053	.0069	.0081	.0109	.0165	.0218
High Temp Alloys Nimonics, Inconel, Monel, Hastelloy	S	up to 42 Rc	•	x	x	22	.0010	.0020	.0030	.0033	.0043	.0051	.0069	.0102	.0137
Titanium Alloys 6Al-4V, 5Al-2.5 Sn, 6Al-2 Sn-4Zr-6Mo, 3Al-8V-6Cr4Mo-4Zr, 10V-2Fe-3Al, 13V-11Cr-3Al	S	up to 42 Rc	•	x	x	45	.0010	.0020	.0030	.0033	.0043	.0051	.0069	.0102	.0137
Aluminum < 10 % Si	N		•			228	.0038	.0078	.0114	.0139	.0175	.0208	.0279	.0419	.0558
Aluminum > 10 % Si	N														